

# Pre-service teachers' competence in using dynamic worksheets to promote functional thinking

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*Keywords: Multiple representation system, pre-service mathematics teacher, teacher professional development, functions.*

The potential of digital technologies in the classroom has been confirmed many times. This is in contrast to findings that digital media are hardly used in everyday school life, especially in the hands of learners. One possible reason for this is that teachers lack competence to use digital technologies in the classroom. In this study, we look at what professional competence is needed to use dynamic worksheets for fostering functional thinking, what competence our pre-service teachers have without training and how the competence develops through training within a university course.

## Theoretical background

According to Blömeke et al. (2015), teachers' professional competence can be seen as a continuum, starting with their individual dispositions enriched by situation-specific skills and finally results in performance behaviour. With regard to digitalisation and teaching functions with dynamic worksheets, the cognitive disposition consists of the dimensions of the TPACK-model (Mishra & Koehler 2006). These cognitive dispositions are visualised via situation-specific skills (perception, interpretation, decision-making) for observable performance. These would be to plan and construct dynamic worksheets, use them in the classroom and evaluate their use. Roth et al. (2023) added the learners' perspective in their *model of teachers' professional competence* since all the aspects of teachers' professional competence mentioned so far have an impact on the competence of learners, which in turn can be measured by their performance. Since we already know that the use of dynamic worksheets can promote learners' functional thinking (Lichti & Roth, 2018; Digel & Roth, 2022), we focus on pre-service teachers' competence of using dynamic worksheets for promoting functional thinking in this study.

## Methodology

During a university course, 21 pre-service teachers were recorded while evaluating dynamic worksheets thinking aloud. We collected data at three points of time in order to make a development visible within the course in which the pre-service teachers design dynamic worksheets, use them in classrooms and reflect their usage. Data is then analysed with qualitative content analysis. The main categories are derived from the theoretical background, including the three situation-specific skills. The category *justification* was added to track whether students were basing their interpretation on something and if so, on what.

## Preliminary results

Preliminary results show that at the beginning of the course most pre-service teachers act almost exclusively on a perceptual level when evaluating dynamic worksheets. In addition, most of them perceive the accompanying tasks and the interactivity. In particular, the potential of the use of

dynamic worksheets, multimedia principles and the learner’s perspective are not considered at all for most of our pre-service teachers. Table 1 shows the situation-specific skills of a typical student.

	Time 1	Time 2	Time 3
Perception	7	7	13
Interpretation	3	7	9
Justification	3	4	8
Decision-making	2	7	9
Sum	15	25	39

**Table 1: Situation-specific skills**

Because of the treatment within the course, most of the pre-service teachers were able to perceive other aspects of the dynamic worksheet as well as interpret those more often. Moreover, they were able to make decisions about why and how to use dynamic worksheets in class or what they would change before using them. In addition, table 1 also shows that not only did the number of interpretations and decisions increase over time, but also that they were justified more frequently.

## References

- Blömeke, S., Gustafsson, J. E., & Shavelson, R. (2015). Beyond dichotomies: Competence viewed as a continuum. *Zeitschrift für Psychologie*, 223(1), 3–13.
- Digel, S., & Roth, J. (2022). Why introductory experiments on functional relationships should be qualitative to foster covariation. In J. Hodgen, E. Geraniou, G. Bolondi, & F. Ferretti. (Eds.), *Proceedings of the Twelfth Congress of European Research Society in Mathematics Education (CERME12)* (pp. 2701–2708). Free University of Bozen-Bolzano and ERME.
- Lichti, M., & Roth, J. (2018). How to foster functional thinking in learning environments using computer-based simulations or real materials. *Journal for STEM Education Research*, 1(1–2), 148–172. <https://doi.org/10.1007/s41979-018-0007-1>
- Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record*, 108(6), 1017–1054. <https://doi.org/10.1111/j.1467-9620.2006.00684.x>
- Roth, J., Eilerts, K., Baum, M., Hornung, G., & Trefzger, T. (2023). Die Zukunft des MINT-Lernens – Herausforderungen und Lösungsansätze [The Future of STEM Learning - Challenges and solutions]. In J. Roth, M. Baum, K. Eilerts, G. Hornung, & T. Trefzger (Eds.), *Die Zukunft des MINT-Lernens – Band 1. Perspektiven auf (digitalen) MINT-Unterricht und Lehrkräftebildung* (pp. 1–42). Springer Spektrum.